**ORIGINAL ARTICLE**

# Comparison of pain and Oxford score of patients who underwent TKA with two methods of mechanical and kinematic alignment techniques

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## ABSTRACT

**Introduction:** At present, the first choice for severe joint diseases is total knee arthroplasty, which can relieve joint pain, correct deformity, and improve joint function. This study aimed to assessment comparison of pain and Oxford score of patients who underwent TKA with two methods of mechanical and kinematic alignment techniques.

**Method and Material:** This study is a prospective clinical Trial study that was performed on patients who underwent total knee arthroplasty. Sixty-four patients with a definitive candidate of TKA scheduled for TKA were randomized into kinematically aligned TKA and mechanically aligned TKA. Data were collected by Visual analogue scale (VAS) questionnaire for pain and Oxford score questionnaire for pain and function of patient at one, twenty and ninety days after operation. For data analysis, SPSS 26 software and descriptive statistical methods of mean, Chi-square, Fisher's exact test, independent t-test, Paired T-test, one Way ANOVA and Repeated Measure test were used. P-value less than 0.05 were considered to be statistically significant.

**Result:** mean of VAS score showed a statistically significant difference between the Kinematic and Mechanical group so that in Kinematic group was statistically significantly lesser than Mechanical group in all three time after operation and the mean of Oxford score and its two domains including pain and function showed a statistically significant difference between the Kinematic and Mechanical group so that in Kinematic group was statistically significantly lesser than Mechanical group in its both two domains in 20 and 90 days after operation.

**Conclusion:** It seems that the kinematic method results in better function and less pain for patients versus mechanical method due to better alignment during surgery.

## INTRODUCTION

Osteoarthritis is the most widespread joint disease in the elderly, and knee osteoarthritis (KOA) is more frequent than osteoarthritis of the hip or ankle[1, 2]. It has been predicted that in 2020, osteoarthritis will be the fourth most common cause of disability worldwide [3]. At present, the first choice for severe joint diseases (Kellgren–Lawrence score ≥ 3) is total knee arthroplasty (TKA), which can relieve joint pain, correct deformity, and improve joint function, and many studies have suggested that the long-term survival rate could reach more than 90% after 15 years [4-6]. The number of total knee arthroplasties performed in the United Kingdom has been increasing each year with more than 90 000 being recorded by the National Joint Registry of England, Wales and Northern Ireland in 2013[7]. The ten-year revision risk for cemented, unconstrained fixed bearing TKA is just over 3%[7]. It has been estimated that by 2030, every year, 3.8 million people will undergo TKA[8]. TKA is now a more common procedure than total hip arthroplasty (THA) but satisfaction following TKA remains inferior[9, 10]. Although the survival rate of TKA has improved, approximately 20%–25% of patients remain unsatisfied with the outcome[11]. Despite several perevious studies even in complications of bilateral TKA the cause of this dissatisfaction is not clear [7]. Proper alignment of the knee is one of the most important factors in determining long-term implant survival after total knee arthroplasty [12]. The standard surgical techniques for TKA use 2 different alignment methods for prosthesis implantation: mechanical alignment (MA) and kinematic alignment (KA). The MA technique aims to create a neutral lower limb axis by cutting the distal femur and proximal tibia perpendicular to the femoral and tibia mechanical axes and provides reliable long term fixation and functional improvement[13]. In addition, navigation-assisted TKA has been shown to better replicate the neutral MA of the knee, leading to fewer alignment outliers[14, 15]. However, the MA technique with or without navigation can lead to unfavorable results, including abnormal tightening or slackening of the collateral, posterior cruciate, and retinacular ligaments and abnormal contact kinematics caused by changing the angle and level of the natural joint line, leading to unsatisfactory outcomes in up to 25% of patients [11, 16]. Thus, the KA technique has increased in popularity. This technique aims to restore the 3 functional axes that determine normal knee kinematics based on an understanding of predictable patterns of cartilage wear and lack of bone wear in arthritic knees. The KA technique is associated with improved postoperative satisfaction and function[17, 18]. However, there are also potential concerns with the KA technique: restoring natural varus can increase the risk of early implant failure and poor function because the tibia component is aligned with the natural, pre-arthritic joint lines of the knee and not perpendicular to the mechanical axis of the tibia [18]. Pain is one of the strongest determinants of satisfaction of

patient that underwent TKA, for a number of reasons: First, pain is usually the primary indication for joint replacement. Secondly, patients have been shown to have higher expectations of relief from pain when compared with other outcome after TKA[19]. Thirdly, it is relatively easy for patients to modify their level of activity, change their behavior and adapt their environment so that functional deficiencies are overcome. By contrast, pain is less amenable to changes in lifestyle and behavior and often remains a cause of considerable distress[9]. Patient-reported measures of knee function are important for the comprehensive assessment of conditions in both clinical and research contexts[20]. The Oxford knee score (OKS) is a validated and widely accepted disease-specific patient-reported outcome measure [21] that can predict patient's satisfaction of function after TKA with good accuracy after TKA [22] and it can be used as a predictor of revision of the implant[16]. Although many studies have reported the clinical and radiographic outcomes of patients who underwent TKA with mechanical and kinematic alignment techniques, few comparative studies have been published on comparison of pain and function of patient who underwent TKA with mechanical and kinematic alignment techniques. Therefore this study aimed to investigate comparison of pain and function of patients who underwent TKA with two methods of mechanical and kinematic alignment techniques.

## METHOD AND MATERIAL

**Study design and setting:** This study is a prospective clinical Trial study with practical objectives that was performed on patients who underwent total knee arthroplasties in the orthopedic department of Imam Hossein Hospital in Tehran, Iran in 2019 - 2020. This hospital is one of the major hospitals in Tehran for hospitalizing of orthopedic patients who underwent total knee arthroplasties.

**Participants:** Sixty-four patients with a definitive candidate of TKA scheduled for TKA at our hospital were enrolled in the study and were randomized into kinematically aligned TKA and mechanically aligned TKA, based on inclusion and exclusion criteria. Inclusion criteria included substantial pain and loss of function due to arthritis of the knee and varus deformity with or without flexion contraction. Patients with a history of fracture of the tibia or femur, infection, previous joint replacement, Charcot joints, Valgus deformity, previous osteotomy about the knee, or medical condition precluding surgery, active rheumatoid arthritis and Opium addiction were excluded. At first, informed and written consent was received from all patients. The demographic characteristics questionnaire was completed and then the patients were divided into two groups, joint replacement surgery by kinematic method and joint replacement surgery by mechanical method by using simple random sampling.

**Surgical Technique Kinematically Aligned TKA**: A TKA is Kinematically Aligned when the positioning of the femoral and tibial components are designed to restore the three axes that govern the Kinematics of the normal knee[23]. The guides were sterilized per company instructions and opened on the sterile field preoperatively. Before the onset of the procedure, patient initials, birth date, and implant size and side (left or right) were confirmed by comparing the information on the guides with the patient information and the surgical plan. One tray of TKA instruments and correct size trials was required for each procedure. The anterior fat pad was excised in all cases. The femoral patient-specific guide was placed on the distal femur by sliding the trochlear portion of the guide distally and posteriorly until the guide locked into place. The guide was then compressed against the distal femur and secured by drilling 2 pins through the pin holes in the distal surface of the guide into the femoral articular surface, and by drilling 2 pins through the pin holes in the anterior surface of the guide. The distal cut on the femur was made through the saw slot of the patient-specific guide. The conventional4-in-1 cutting block that matched the size of the planned femoral component was placed into the 2 pin holes in the distal femoral articular surface, and the anterior, posterior, and chamfer femoral cuts were made. A posterior cruciate retractor was used to sublux the tibia anteriorly on the femur, and the patellar tendon was retracted gently with a collateral ligament. The tibia patient-specific c guide was then placed, checking to be sure it was seated both medially and laterally, compressed axially, and secured by drilling 2 pins through the pin holes on the proximal surface on the tibia guide, and by drilling 2 pins through the pin holes in the anterior surface of the guide. The tibia cut was made through the slot in the guide, and marginal osteophytes on the tibia and femur were removed with an osteotome. Posterior osteophytes were removed and a posterior capsular release was performed when there was a flexion contracture. Medial and lateral osteophytes were removed to restore length to the collateral ligaments. Trial components were placed, and knee ROM, joint stability; implant rotation, posterior cruciate ligament (PCL) tension, and patellar tracking were checked. Stability, motion, and limb alignment were achieved in each kinematically aligned knee without release of the medial or lateral collateral ligaments or the PCL. The internal–external rotation of the tibia component was aligned parallel to the pinholes drilled through the proximal surface of the tibia guide. The definitive implants were cemented, with care to remove all excess cement. The wounds were closed in layers after final irrigation[24].

**Mechanically Aligned TKA:** Mechanically aligned TKA was performed as described in the technique manual provided by the manufacturer. Eight standard instrument trays were used for the procedure. The anterior fat pad was excised in all cases. The distal femoral bone cut was made with an intramedullary alignment system with the angle of the distal resection set at 5° of valgus. The posterior femoral bone cuts were made with a posterior referencing guide set at 3° of external rotation. The tibia bone cut was made with an intramedullary alignment system or with use of an extra medullary alignment in cases of severe varus bowing of the tibia. Significant posterior osteophytes were removed at this time with a three-quarter inch curved osteotome. Trial components were placed, and knee ROM, joint stability, PCL tension, and patellar tracking were checked. Release of the collateral and retinacular ligaments was performed when necessary at the discretion of the co-surgeons. The definitive implants were cemented,

with care to remove all excess cement. The wounds were closed in layers after final irrigation[24].

**Postoperative Management:** Postoperative management was identical for both groups. The patient, physical therapist, and clinical evaluator who collected the clinical data and examined the patients were blinded to each patient's alignment method.

**Data collection:** Data were collected by Visual analogue scale (VAS) questionnaire for pain and Oxford score questionnaire for pain and function of patient at one, twenty and ninety days after operation. The Oxford knee score is a patient-administered questionnaire which explores a subjective assessment of their pain and functional capacity. It is administered as a 12-part questionnaire, with five questions relating to the measurement of pain, and seven to the assessment of function. The answer to each question is rated on a scale ranging between 1 and 5, with higher scores indicating more severe problems. The scores for each question are added to generate an overall score of between 12 and 60. The Oxford knee score was chosen because it is a reliable, valid and responsive outcome measurement [9]. The visual analogue scale (VAS) questionnaire is a standard instrument for measuring the severity of patients' pain, which is scaled from 1 to 10. A lower score indicates less pain and a higher score indicates more pain [25]. Clinical evaluators who collected the clinical data and examined the patients were blinded to each patient's alignment method.

**Statistical Analysis:** Data were collected by Continuous sampling method**.** For data analysis, SPSS 26 software and descriptive statistical methods of mean, Chi-square, Fisher's exact test, independent t-test, Paired T-test, one Way ANOVA and Repeated Measure test were used. P-value less than 0.05 were considered to be statistically significant.

**Ethical considerations:** This study has taken from a research project with Ethical code (IR.SBMU.MSP.REC…..), approved by the Vice President of Research of Shahid Beheshti University of Medical Sciences, Tehran, Iran. Ethical considerations in this study have been confirmed by obtaining the code of ethics from the Vice President of Research of Shahid Beheshti University of Medical Sciences.

## RESULT

The results have shown that 43.7 percent of patient's in kinematic group was Female and 56.3 percent was male versus 49.9 percent female and 53.1 percent male in mechanical group. Mean age in kinematic group was 62.93 ± 6.03 versus mechanical group 65.25 ± 6.84. The cause of disease in all patients in both groups was osteoarthritis. Demographic characteristics in two groups were homogenous. (Table 1).

**Table 1:** Demographic characteristics of patients in two groups

| **Variables** | **Kinematic**<br>**Frequency (Percent)** | **Mechanical**<br>**Frequency (Percent)** | **P-value** |
|---|---|---|---|
| | **Sex** | | |
| Female | 14 (43.7) | 15 (46.9) | P = 0.80 |
| Male | 18 (56.3) | 17 (53.1) | |
| | **Side** | | |
| Right | 15 (46.9) | 18 (56.2) | P = 0.45 |
| Left | 17 (53.1) | 14 (43.8) | |
| | **Age** | | |
| Year | 62.93 ± 6.03 | 65.25 ± 6.84 | P = 0.15 |
| | **BMI** | | |
| $Kg/m^2$ | 27.08 ± 3.35 | 26.75 ± 3.36 | P = 0.70 |

The results showed that the mean of VAS score showed a statistically significant difference between the Kinematic and Mechanical group so that its mean in Kinematic group was statistically significantly lesser than Mechanical group in all three time after operation. (Table2, Fig 1)

**Table 2:** Comparison of VAS Score after one, 20 and 90 day post operation between two group of Kinematic and Mechanical

| **Time**<br>**Group** | **After one day**<br>Mean ± Std.D | **After 20 days**<br>Mean ± Std.D | **After 90 days**<br>Mean ± Std.D | **P-value** |
|---|---|---|---|---|
| Kinematic | 4.84 ± 1.37 | 2.09 ± 0.88 | 1.31 ± 89 | P < 0.001 |
| Mechanical | 5.96 ± 1.2 | 2.81 ± 0.89 | 2.1 ± 1.05 | P < 0.001 |
| P-value | 0.001 | 0.002 | 0.001 | |

The mean of Oxford score and its two domains including pain and function showed a statistically significant difference between the Kinematic and Mechanical group so that its mean in Kinematic group was statistically significantly lesser than Mechanical group in its both two domains in 20 and 90 days after operation. (Table3, Fig 2)

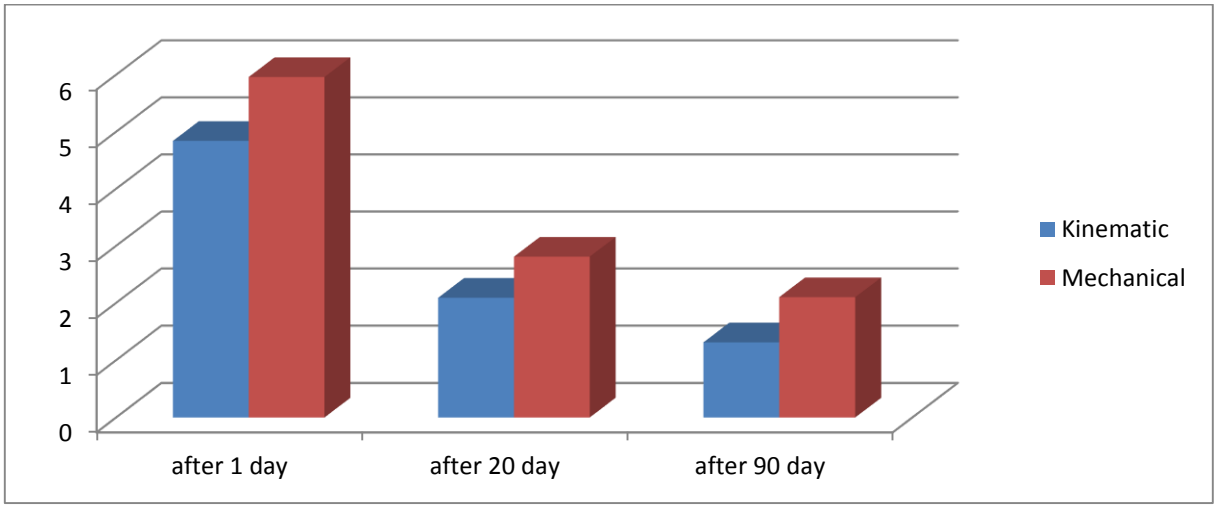


**Fig1:** Comparison of VAS Score after one, 20 and 90 day post operation between two group of Kinematic and Mechanical.

**Table 3:** Comparison of Oxford score mean in two group of kinematic and mechanical

| **Time**<br>**Group** | **After 20 day**<br>Mean ± Std.D | **After 90 days**<br>Mean ± Std.D | **P-value** |
|---|---|---|---|
| | **Total Oxford score** | | |
| Kinematic<br>Mechanical<br>P-value | 36.75 ± 8.45<br>42.59 ± 3.61<br>P < 0.001 | 31.21 ± 4.57<br>35.53 ± 5.74<br>P = 0.002 | P = 0.007<br>P < 0.001 |
| | **Oxford score (Pain)** | | |
| Kinematic | 14.59 ± 3.95 | 12.87 ± 2.59 | P = 0.041 |
| Mechanical | 16.78 ± 2.13 | 14.62 ± 3.11 | P = 0.005 |
| P-value | P = 0.008 | P = 0.018 | |
| | **Oxford score (Function)** | | |
| Kinematic | 22.15 ± 5.37 | 18.34 ± 3.18 | P = 0.006 |
| Mechanical | 25.81 ± 2.68 | 20.90 ± 3.72 | P < 0.001 |
| **P-value** | **P = 0.001** | **P = 0.004** | |

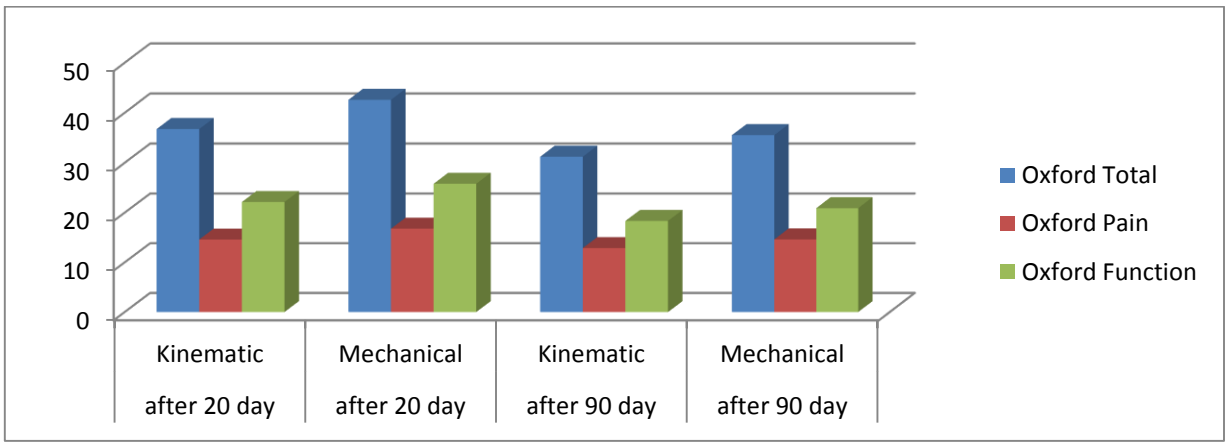


**Fig 2:** Comparison of Oxford Score and its domains after 20 and 90 day post operation between two group of Kinematic and Mechanical.

## DISCUSSION

This study aimed to investigate Comparison of pain and Oxford score of patients who underwent TKA with two methods of mechanical and kinematic alignment techniques. our study showed that VAS score in Kinematic group was statistically significantly lesser than Mechanical group in all three time after operation that this means less pain of patients in Kinematic group, this finding was confirmed by previous studies, such Howell SM [26], Shaw JA [27] and Dossett HG [28] & et.al. In these studies Patients who underwent the Kinematic method versus Mechanical method, had less postoperative pain. One study showed that kinematically aligned knee replacement is associated with less pain and more patients' satisfaction versus Mechanical method[29]. In a study in 2014, Dossett & et al. found that the kinematic method caused less pain

to patients versus mechanical method [28]. Young & et al. reported that patients who underwent kinematic method experienced less postoperative pain versus patients who underwent mechanical method [30].

In the kinematic method the soft tissues around the joint are not released, but in the mechanical type, the soft tissues are released with the aim of balancing the ligament of the joint. In addition, not changing the kinematic axes of the knee in the kinematic alignment method can be effective in reducing the severity of pain. The lesser pain of kinematic surgery method can cause faster return of range of motion and return to daily activities and reduced need for walkers.

Our study showed that Oxford score and its two domains including pain and function showed a statistically significant difference between the Kinematic and Mechanical group so that its mean in Kinematic group was statistically significantly lesser than Mechanical group in its both two domains, this finding was confirmed by previous studies such: Dossett & et.al reported less Oxford score in Kinematic method versus Mechanical also they reported that function score in Kinematic method was lesser [24]. Dutton & et.al also reported less Oxford score in Kinematic method versus Mechanical [31]. Zhenyu & et al. found that the kinematic method reduces the Oxford score and thus increases the patients' function versus mechanical method [32]. One systematic review study showed that Kinematic technique resulted in a significantly less Oxford score and better overall functional outcome versus Mechanical technique [12] another systematic review study in 2018 showed that the kinematic method causes better postoperative function and oxford score versus Mechanical method [33].

while some study contradicts to present study found that there is no difference of Oxford Score in Kinematic method versus Mechanical such: young & et.al [34], Peter & et.al [35], Nogler & et.al [36], Laende & et al [37] and two systematic review such as Young & et.al [30] and Sappey-Marinier & et.al [38].

It seems that in the kinematic method, there is no release of soft tissues and ligaments around the knee and this can improve the stability of the joint and the patient's movements after surgery and speed up the patient's function and recovery process after surgery. Also, the more anatomical alignment and articular line of the implant in the kinematic method causes better function and clinical results for patients. Improving the Oxford score in the kinematic method could predict a lower implant revision rate in patients who underwent with this surgical procedure.

Research finding showed that some factors such as motivation, commitment and empowerment which are necessary components for adherence to treatment in patients and they can effect on the outcomes of surgery, therefore, considering these factors is suggested for more research in the future[39].

## CONCLUSION

It seems that the kinematic method results in better function and less pain for patients versus mechanical method due to better alignment during surgery.

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